

Delta 2 finishes its 29-year run as America's trusty medium-lift workhorse

by **Debra Werner** — October 15, 2018



A Delta 2 lifts off Sept. 15 from Vandenberg Air Force Base in California on its 155th and final mission. In its final outing, the United Launch Alliance rocket delivered NASA's ICESat-2 satellite to orbit, capping a career that included 153 flawless missions, one explosive failure and one partial success. Credit: NASA

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With the Sept. 15 launch of NASA's second Ice, Cloud and land Elevation Satellite, Delta 2 sealed its reputation as one the most reliable rockets in history. Still, one of its most enduring images was its single failure.

On Jan. 17, 1997, 13 seconds after a Delta 2 lifted off from Cape Canaveral Air Station carrying the first U.S. Air Force GPS Block 2R satellite, a solid rocket motor failed, triggering flight termination and a spectacular explosion 490 meters above the launch complex.

“That was incredibly gut-wrenching to the team because Delta 2s never failed,” said Tim Dunn, NASA Kennedy Space Center launch director who was a Boeing Delta 2 guidance engineer in 1997. “If there was a failure in the long history of Delta, it occurred down-range instead of raining debris down over the parking lot, the block house and the launch pad.”

The Delta program recovered quickly, sending five Iridium communications satellites into low Earth orbit less than 16 weeks later, on May 5, from Vandenberg Air Force Base in California and launching Hughes Space and Communications’ Thor 2 broadcasting satellite from Cape Canaveral May 24.

“My fondest memory from that failure was watching the team successfully launch again on that same rocket design less than five months later,” Dunn said. “We found the cause of the failure, did the necessary mitigation and took corrective action.”

As the Delta 2 program ends, participants, customers and onlookers are comparing memories. From 1989 to 2018, the Delta 2, originally built by McDonnell Douglas, based on Douglas Aircraft Company’s Delta rocket, and later by Boeing and United Launch Alliance, performed 153 flawless missions, one explosive failure and one partial success. In 1995, a Delta 2 sent the South Korea’s Koreasat 1 communications satellite far lower than its intended orbit when one of nine solid rocket motors failed to separate from the first stage. The satellite later propelled itself into its correct orbit, cutting into its supply of onboard fuel.

In its 153 successful flights, Delta 2’s launched satellites for the U.S. Air Force, National Reconnaissance Office, Missile Defense Agency, NASA and commercial customers into Earth orbit. NASA satellites also flew Delta 2s to Mars, Mercury, comets and asteroids.

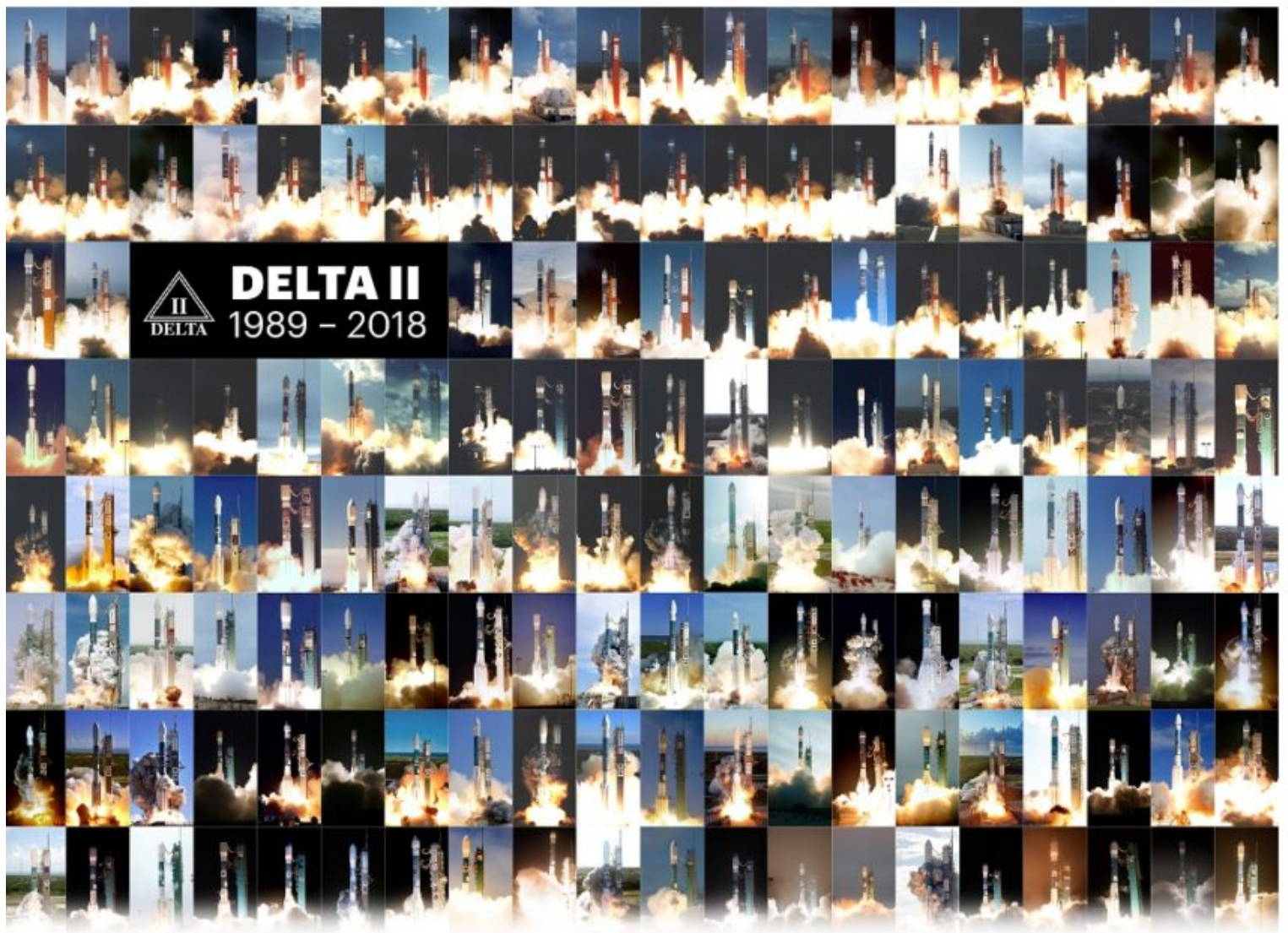
NASA scientists, in particular, saw Delta 2 as a remarkably reliable workhorse. After a Taurus XL failed, send NASA’s first Orbiting Carbon Observatory (OCO) into the ocean in 2009, Principal Investigator David Crisp was surprised to learn its twin OCO-2 would fly on Delta 2.

“I was surprised because the Delta 2 was far more powerful (and expensive) than we needed to deliver OCO-2 to the A-Train,” Crisp said by email. “I was relieved because I had successfully flown several missions on the Delta 2 (Mars Pathfinder, Deep Space 1, Earth Observing-1, Mars Polar Lander, CloudSat) and knew that it was the most reliable launch vehicle in the fleet.”

In all, NASA claimed 54 Delta 2s, which the agency often purchased in bulk. In the early 2000s, for example, NASA awarded Boeing a contract for 19 Delta 2 flights.

For the next decade, science and planetary mission designers, who were familiar with the medium-lift rocket’s performance envelope, fairing size and flight dynamics, knew they could design spacecraft for Delta 2, Dunn said. “That’s one reason our science community especially really loved it,” he added.

Delta 2 was the perfect size for NASA missions since most of the agency’s payloads are in the 1,500-kilogram to 3,000-kilogram range, said John Satrom, director of NASA Goddard Space Flight Center programs for Stellar Solutions, an aerospace systems engineering and integration company based in



Over 29 years, the workhorse Delta 2 rocket launched 155 missions for the U.S. Air Force, NASA, the National Reconnaissance Office and commercial customers. Among its achievements, Delta 2 launched 48 GPS satellites for the Air Force, sent NASA's Spirit, Opportunity and Phoenix missions on their way to Mars, and orbited commercial satellites for Iridium, Globalstar and DigitalGlobe. Credit: United Launch Alliance photo illustration

Palo Alto, California. "Going forward, we will be flying on launch vehicles where we are using half (or less) of the available performance," Satrom said by email.

Delta 2's lift capacity of 6,100 kilograms to low Earth orbit is dwarfed by the expendable rockets the Air Force relies on today. Variants of Atlas 5 max out at 18,850 kilograms, Falcon 9 at 22,800 kilograms and Delta 4 at 28,370 kilograms.

"Delta 2 was designed for the sweet spot for low Earth orbit and medium Earth orbit capabilities, markets and missions, both government and commercial — including many Ball missions for our customers," said Debra Facktor, Ball Aerospace strategic operations vice president and general manager.

Now, the market for medium-lift rockets is much weaker. Communications satellites destined for geostationary orbit tend to require heavy-lift, while most new Earth observation and communications satellites are getting smaller thanks to miniature electronics, said Jim Cantrell, Vector Launch co-founder and chief executive. Northrop Grumman's Antares rocket, designed to loft up to 8,000 kilograms to low Earth orbit, is the closest match to Delta 2.

In Delta 2's heyday, medium-lift was in high demand. After the Space Shuttle Challenger broke apart after liftoff in 1986, tragically killing its seven-person crew, the Reagan Administration called for new expendable rockets. The next year, the Air Force awarded McDonnell Douglas a contract to upgrade its Delta rocket, a modified Air Force Thor intermediate-range ballistic missile.

"Delta 2 was there when our country needed it after the loss of Space Shuttle Challenger; allowing deployment of the U.S. Air Force's Global Positioning System satellites, which really marked the beginning of GPS use as we know it today," Latanjia Robinson, Aerojet Rocketdyne chief engineer for AJ10 rocket engine, which powered Delta 2's second stage, said by email. "From an Aerojet Rocketdyne perspective, the longevity and mission success of Delta 2 allowed the RS-27 [Delta 2 first-stage engine] and AJ10 propulsion systems to shine and do what they have done so well for so many decades."

GPS was Delta 2's most frequent flier.

"By launching 48 GPS satellites and establishing the operational constellation, it marked itself as a tremendously capable, reliable, low-cost rocket for our nation," Dunn said.

Costs began to rise sharply after the Air Force opted in 2007 to stop flying Delta 2s in favor of Atlas 5 and Delta 4. Delta 2 prices rose from \$51 million in 1987 to \$96.6 million for the Delta 2 NASA purchased in 2013 to launch ICESat-2.

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DELTA 2



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